Claims

1. A method for synchronizing transmission of frames in a telecommunications network comprising a first end node, a second end node, at least one middle node via which a connection is established between the end nodes, wherein the first end node and the at least one middle node have a corresponding timing reference;

the method comprising the steps of:

establishing a connection-specific timing reference which is common to all nodes involved in the connection;

determining, for at least one middle node an offset which is related to the difference between the timing reference of the middle node in question and the connection-specific timing reference; and

using the information about the offset to compensate for the difference between the timing references.

2. A method according to claim 1, further comprising:

the at least one middle node using the offset for synchronizing its timing reference with that of the second end node.

3. A method according to claim 1, wherein the network comprises a first middle node via which the connection is established and at least one second middle node; and wherein the offset is used by at least each second middle node.

4. A method according to claim 1, further comprising:

the end nodes synchronizing their timing references on the basis of the time when a predetermined message is sent between the end nodes.

5. A method according to claim 1, further comprising:

the end nodes synchronizing their timing references on the basis of the time when the connection between the end nodes is established.

6. A method according to claim 1, wherein the connection-specific timing reference comprises at the end nodes:

a connection-specific frame number, which is stepped at predetermined intervals and which has a finite length such that the connection-specific frame number has a period which is substantially shorter than the duration of a typical connection; and

a frame number extension which is stepped when the connection-specific frame number completes one period.

7. A method according to claim 6, further comprising:

the end nodes using the connection-specific frame number and the frame number extension for ciphering and deciphering the frames.

8. A method according to claim 6, further comprising:

the end nodes using the frame number extension and another sequence number for ciphering and deciphering the frames.

9. A method according to claim 8, wherein the other sequence number is a protocol data unit number.

10. A method according to claim 6, further comprising:

the end nodes employing ciphering in more than one protocol layer;

using the connection-specific frame number and the frame number extension for ciphering and deciphering the frames in a first layer, and

using the frame number extension and another sequence number for ciphering and deciphering the frames in another layer.

11. A method according to claim 6, further comprising:

the end nodes employing ciphering in more than one protocol layer or for two or more parallel bearers so that there are parallel ciphering counters running independently, and

using the frame number extension as an initialization parameter of the parallel ciphering counters.

12. A method according to claim 1, further comprising:

each middle node useing the connection-specific timing reference for determining the time of transmission towards the first end node and/or for determining a frame number for frames towards the second end node.

13. A method according to claim 12, wherein, in a case where a middle node can only send a frame at a point of time which is later than the time which corresponds to the connection-specific timing reference, the middle node in question provides the frame with a correction indicator, which indicates, directly or indirectly, the amount of time by which the frame was delayed.

14. A method according to claim 12, wherein the offset for the middle node in question also comprises a fractional offset part which approximately corresponds to the propagation delay of a frame between the end nodes.

15. A method according to claim 1, further comprising:

the first end node obtaining measurement results from the at least one middle node and sending the measurement results to the second end node; and

the second end node using the measurement results for determining the offset for the middle node in question.

16. A method according to claim 1, further comprising:

the end nodes synchronizing their timing references with the timing reference of one of the at least one middle node involved in the connection.

17. A method according to claim 16, further comprising:

the end nodes synchronizing their timing references to the timing reference of the first middle node involved in the connection.

18. A method according to claim 1, wherein the first end node is a mobile station, each middle node is a base station and/or a controlling radio network controller, and the second end node is a serving radio network controller.

19. A method according to claim 1, wherein at least some frames comprise an indication on whether or not the frame in question comprises ciphered data.

20. A method according to claim 6, further comprising:

the first end node sending to the second end node an initialization parameter for the frame number extension, and

the second end node initializing, on the basis of the initialization parameter, the frame number extension to a value which exceeds the last value of the frame number extension during a previous connection.

21. A method according to claim 20, further comprising:

forming the initialization parameter of the last value of the frame number extension or of a number n of most significant bits in the last value of the frame number extension.

22. A method according to claim 20, further comprising:

the first end node sending the initialization parameter in response to a detected need for establishing, re-establishing or handing over a connection.

23. A method according to claim 20, further comprising:

the first end node sending the initialization parameter to the second end node in one or more of the following ways:

on a Random Access Channel;

on a dedicated channel;

in a message relating to an authentication procedure; or

in a CIPHERING MODE COMPLETE message.

24. A method according to claim 20, further comprising:

in case of a handover from a second generation mobile network to a third generation mobile network, the first end node sending the initialization parameter to the second end node in a HANDOVER COMPLETE message.

25. A method according to claim 20, further comprising:

in case of a handover from a second generation mobile network to a third generation mobile network, the first end node sending the initialization parameter to the second generation mobile network which forwards it to the second end node.

26. A method according to claim 20, further comprising:

at the end of a connection, the first end node storing into a memory a value which comprises information about the last or the biggest frame number extension used during the connection in question; and

at the beginning of the next connection, the first end node reading from the memory the value stored in the previous step and using the value for forming the initialization parameter.

27. A method according to claim 20, further comprising:

performing separate ciphering for at least two parallel bearers,

during the connection, the first end node reading from the memory the last or highest value of the frame number extension used during the previous connection and using the read value for forming the initialization parameter when a new bearer is to be added to the connection.

28. A method according to claim 20, further comprising:

performing separate ciphering for at least two parallel bearers,

the first end node recording the highest value of the frame number extension used during the connection and using the value for forming the initialization parameter when a new bearer is to be added to the connection.

29. A method according to claim 26, wherein the storing step comprises marking the stored value with an unused status and the reading step comprises marking the stored value with a used status.

30. A first end node for forming a connection to a second end node via at least one middle node in a telecommunications network, wherein the first end node and each middle node have a corresponding timing reference; wherein the first end node is adapted to co-operate with the second end node, for:

establishing a connection-specific timing reference which is common to all nodes involved in the connection, and

determining, at least for one middle node, an offset which is related to the difference between the timing reference of the middle node in question and the connection-specific timing reference.

31. A first end node according to claim 30, wherein the connection-specific timing reference comprises:

a connection-specific frame number, the value of which is stepped at predetermined intervals and which has a finite length such that the connection-specific frame number has a period which is substantially shorter than the duration of a typical connection; and

a frame number extension which is stepped when the connection-specific frame number completes one period; and that

when a connection is being established, re-established or handed over, the first end node is adapted to send to the second end node an initialization parameter for the frame number extension, for initializing the frame

number extension to a value which exceeds the last value of the frame number extension during a previous connection.

32. A second end node for forming a connection to a first end node via at least one middle node in a telecommunications network, wherein the first end node and each middle node have a corresponding timing reference;

wherein the second end node is adapted to:

co-operate with the first end node, for establishing a connection-specific timing reference which is common to all nodes involved in the connection, and for determining, at least for one middle node, an offset which is related to the difference between the timing reference of the middle node in question and the connection-specific timing reference; and

use the information about the offset to compensate for the difference between the timing references.

33. A second end node according to claim 32, wherein the second end node is adapted to convey the information about the offset to the middle node in question.

34. A middle node for forming a connection between a first end node and a second end node in a telecommunications network, wherein data is sent between the end nodes in frames at least some of which are sent via several middle nodes; and wherein the first end node and each middle node have a corresponding timing reference;

wherein the middle node is adapted to synchronize to a connection-specific timing reference by:

receiving an offset which is related to the difference between its own timing reference and the connection-specific timing reference; and

using the offset to compensate for the difference between the timing references.